Simulation of shrinkage distress and creep relief in concrete repair

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Abstract: This paper addresses the problem of stress buildup in the repair layer of a concrete patch repair system resulting from moisture diffusion. As moisture evaporates from the repair layer into the surrounding ambience of known relative humidity, the hardened concrete substrate restrains free shrinkage movement of the repair layer. As a consequence, primary tensile stresses are set up in the repair layer together with shear and peeling stresses at the interface of the repair layer-concrete substrate. The repair layer under non-uniformly increasing tensile shrinkage stresses undergoes restrained creep in tension, which results in the development of secondary stresses in the system. The secondary stresses due to restrained creep being of opposite sign to that of restrained shrinkage serve to relieve the primary shrinkage stress field and the net or combined stress buildup as a result is reduced. A finite element based computer program used for computing the time dependent moisture loss profile in the repair system is interfaced with a finite element based 2-D stress analysis program for computing the time dependent restrained shrinkage and creep stresses. Variation of normal and shear stresses across depth and width at critical locations in the patch repair and temporal variation of these stresses are presented. Influence of ultimate free shrinkage strain $\varepsilon_{sh\infty}$ and the buildup of tensile stresses versus the evolution of tensile strength capacity f't of the repair is highlighted. Also, possible zones of failure are identified in the repair layer and at the interface of the patch repair system.